# Surface tension between kaon condensate and normal nuclear matter phase [1]

*Michael B. Christiansen, Norman K. Glendenning and Jürgen Schaffner-Bielich*

The possibility of different phase transitions taking place in the superdense interior of neutron stars has been the target of considerable interest during the last few decades, where pion and kaon condensation as well as quark deconfinement have been investigated. But only less than a decade ago was it realized that if the phase transition is of first order, then a geometrically structured extended region will form in the superdense interior of the neutron star, where the two phases are in equilibrium [2].

We calculate for the first time the surface tension and curvature coefficient of a first order phase transition between two possible phases of cold nuclear matter, a normal nuclear matter phase in equilibrium with a kaon condensed phase, at densities a few times the saturation density. We find the surface tension is proportional to the difference in energy density between the two phases squared. Furthermore, we show the consequences for the geometrical structures of the mixed phase region in a neutron star.

To calculate the surface tension between the kaon condensed phase and the normal nuclear matter phase, the profiles of the fields and densities have to be determined across the interface between semi-infinite slabs of each phase. This is done by simultaneously solving the four coupled differential equations for the $K^-$ and the meson fields through a relaxation procedure, where initial guesses for the different profiles are relaxed to their equilibrium values. The boundary conditions at $\pm\infty$ are provided by the bulk values of the kaon amplitude and meson fields for each phase at a fixed $\chi$. The solution for the field quantities across the surface are shown in Fig. 1. From these, the surface tension and curvature correction can be calculated. Surprisingly, they can be very well approximated by

$$\begin{aligned} \sigma_{fit} &= \left(0.00786\,\frac{\epsilon_K-\epsilon_N}{\mathrm{MeV/fm^3}}\right)^2 \mathrm{MeV/fm^2} \\ \gamma_{fit} &= -0.0976\left(\frac{\epsilon_K-\epsilon_N}{\mathrm{MeV/fm^3}}\right)^{3/4} \mathrm{MeV/fm} \end{aligned} \tag{1}$$

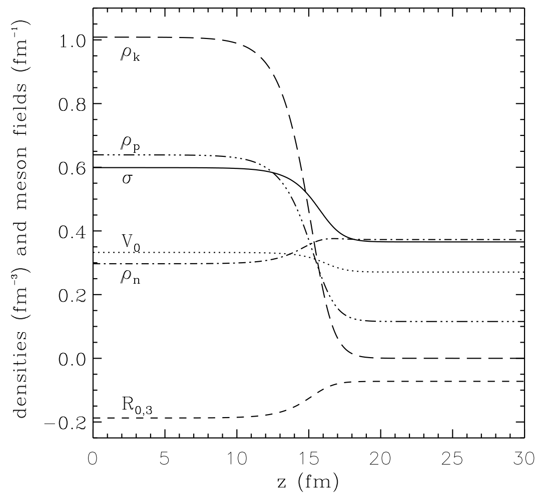


Figure 1: Profiles of the meson fields $\sigma$, $V_0$, and $R_{0,3}$ and the neutron, proton, and kaon densities, $\rho_n$, $\rho_p$, and $\rho_k$, respectively, across the interface. The boundary conditions at $z = 0$ and 30 fm correspond to $\chi = 0.107$.

## References

[1] M. Christiansen, N. K. Glendenning and J. Schaffner-Bielich, Phys. Rev. C **62** (2000) 025804.

[2] N. K. Glendenning, Phys. Rev. D **46** (1992) 1274.